

III. *A Letter from Mr. Anth. Van Leeuwenhoek concerning the Seeds of Plants, with Observations on the manner of the Propagation of Plants and Animals.*

IN the Seed of an *Ash* represented of the natural Size by *Fig. 1.* I observed not only two large Leaves, but that part also whence the Root takes its Rise, was extraordinary big; this part of the Seed I always found upmost when growing on the Tree, so that the Seeds have a contrary Situation on the Tree to what they have in the Earth. These two Leaves of the Seed or Lobes were filled up with an innumerable quantity of very small Globules, except where the Fibres were visible: Which likewise were composed of much smaller Globules, and took their Origine from that part whence the Root proceeds. This supposed Root I cut through the middle, and have represented it *Fig. 2.* wherein the outward Ring represents the Bark, the next represents the woody part full of dark-coloured Pricks, which are the Fibres thereof. The innermost Oval represents the Pith, composed of round Bodies. I have likewise found that the bigness of the Seeds of Plants does no way answer to the Size of the Leaves of the Plant, there being very small Rudiments of the Leaves and Plant in the large Seeds of the Oak and Peach represented by *Fig. 3.* and on the contrary, very considerable ones in the Seeds of the *Ash*.

As I have formerly observed in the fleshy *Fibres* of the *Muscles*, that there were no Blood-Vessels intermixt with them, but they were placed only in the Membranes that encompassed the *Muscles*, and shew'd how the
fleshy

fleshy Muscles might be nourish'd by these Blood-Vessels, so I find the Leaves of Plants to be made up of Globules included in the Membrane that makes the Superficies of the Leaf in all places but where the Fibres are conspicuous. The manner how I suppose these Globules, and by consequence the Leaf is nourish'd is thus: The Liquor or Sap is conveyed in the Vessel *BC*, *Fig. 4.* and is communicated first to the Globule *F*, from that to *G*, thence to *H*, and so on; as if you should put several small Pellets of dry'd Clay in a glass Vessel, if the Water touch but one of them, you will find it communicated by that to the Second, Third, and so on till they are all Wet.

I could not find any thing to satisfy my Curiosity in the small Seeds of *Figs* and *Strawberries*; possibly they were not ripe enough; for I doubt not but that they have the same parts that larger Seeds have.

And if in the small Seeds of the *Ash* (6 whereof weigh not 4 Grains) there are to be seen not only perfect Leaves with their Vessels, but the woody part also, and that from whence the Root shoots out (nay plainer than in the Walnut or Hazel) we may well conclude that wise *Nature* proceeds after the same manner in all its Operations of Generation and Propagation; every Seed containing not only the Rudiments of the future Plant, but also a certain fine Flower to nourish it so long, till striking Root into the Earth, it may thence receive its Nutriment. This Flower is of an oily Nature, and the more oily the longer will the Seeds live out of the ground. And as Plants are not *Male* and *Female*, nor have a *Matrix* for the first Reception and Sustentation of the Young, so the Parent Tree produces a perfect Plant wrapt up in the Seed which the Earth receives and nourishes. I have likewise found that of such Trees as are reckon'd *Male* and *Female*, very few that bore Seeds the last year have bore any this year; so that I question
whether

whether the Trees which we find without Seeds may be therefore called *Male* Trees.

I think it now past all doubt, that the *Generation* of *Animals* is from an *Animalcule* in the *Male* *Sperm*: And tho I have often fancied that I have discovered the Parts and Membranes of the *Fætus* in this *Animalcule*, so as to say there is the Head, there the Shoulders, and there the Thighs, yet I will affirm nothing herein, till I shall be so lucky as to find an *Animalcule* large enough to discover this Truth, which I am not quite in despair of, since I have been so fortunate as to meet with in the small Seeds of the Ash, Leaves and Rudiments of the future Plant far larger than in the Seed of any Plant I have yet examined.

But to examine the matter a little closer : *Nature* proceeds almost after the same Method in her Operations as to the Production of *Plants* and *Animals*: For as the *Animalcule* of the *Male* *Sperm* cannot live in the *Matrix*, without being wrapt up in the several Coverings, and receiving its Nourishment ; so neither can the Seed of the Plant subsist without continual nourishment, and has also its Coats to encompass it: And which is observable, as the *Fætus* has but one ligament consisting of several Vessels, by which it is fastned and nourish'd, so all the Seeds which I have seen have but one Ligament, made up of several Vessels also, which is sometimes longer, sometimes shorter. I will present the Reader with the Draughts of some Seeds. *Fig. 5.* *A B C* is the outward Membrane of the Seed of an *Ash*, *A D* the place where the Seed it self lies, which is taken out and represented by *E F*. *A F* is the Ligament by which the Seed *E F* receives its Nourishment, the part *A* being only joyned to the Tree ; and what is more observable, the point of the Seed *F* where the Ligament is fastned, is likewise the place whence the Root proceeds: So that the Root is the last that parts from the Tree, which at first,

first, while the Seed is young, is upwards ; but afterwards the Seed and Fruit growing heavier, it bends the Stalk, and turns downwards to the Earth. The same thing is in Apples, Pears, &c. These Ligaments by which the Seeds are nourish'd have their Coats or Bark within which, as I guess, are more than 100 small Vessels, in the *Filberd*, all wreathed and twisted up after a Spiral manner, as in *Fig. 6.* It is observable, that this *Ligament* is fastned (in almost all Seeds) to that part whence the *Embrio* Plant arises, as in *Fig. 7.* which represents a *Filberd* larger than the Life, that the Vessels proceeding from the *Ligament* may be more visible. Where the *Ligament* goes from *A* to *B* branching all the way into Ramifications, and they again into lesser, all which meet again at the place whence they began, that is, where the Plant is to have it's beginning.

In the *8th Fig.* I have shewn the *Ligament* of an *Almond*, which being naturally pretty large, I the rather pitch'd upon it. It is cut transverse. *C D E F G* is the *Cortical* part thereof ; it is divided into 7 Partitions meeting at *H*, each whereof is of a reddish Substance ; the Vessels to be seen in one of the spaces are represented by *F G H*, from the View whereof may be collected the great number of Vessels in the whole *Ligament*, by means whereof the Seeds of the *Almond* and *Filberd* are nourish'd : For I could find no difference in the Ligaments of these two Seeds, only in the *Almond* all the parts were larger.

If we consider the Propagation of *Animals*, and that they are so long nourish'd in the *Uterus* by means of the *Umbilical* Vessels, till they are fit for a more open Life, and are then no longer kept Prisoners. And again, that the *Embrio* which is to be the future Plant, perhaps a Tree is so long contained in that Body which we call the Seed, and fed by means of a *Ligament* from its *Matrix*, to wit, the Tree, till it be of a competent growth,
and

and has a sufficiency to provide for it self, and grow when exposed on the bare ground, and then it is no longer kept up. I say, if we consider these two Methods of *Nature*, we shall not find any other difference between *Plants* and *Animals*, than that the first wanting a locomotive Power, cannot couple as *Animals* do, and therefore must contain in the same Individual, not only the Origine of the future *Plants* which I compared to the *Animalcule* in the Male *Sperm*, but also the maternal Nourishment sufficient for it till it is furnish'd with a Root to provide for it self. This Nourishment is a sort of Flour which encompasses the *Embryo* Plant, and in the Seed makes the two Lobes.

If we compare *Plants* with *Birds*, we shall find that as in *Birds* which are Male and Female, it is necessary for the *Animalcule* of the Male already endowed with a living Soul to be placed near the Yelk of the Egg of the Female, to be thence so long nourish'd till it is fit to receive its Food from the Mother, or gather it off the Ground : So in *Plants* the *Embryo* is placed next to a sort of Fine Flour which I compare to the Yelk of the Egg, which not only defends the young Plant, but likewise affords it its first *Aliment*.

We may likewise compare the Propagation of *Trees* with *Fish*, and find the same Agreement. In fine, the Egg in *Animals* seems to be for the same use as the Lobes of the Seed in *Plants*.

Although I have formerly asserted, that the *Female* served only to afford nourishment to the *Animalcules* of the Male *Sperm*, and that *Plants* grow out of the substance wherewith they are watered ; yet I acknowledge for a certain Truth, that a great *Variety* is caused in *Animals* by the Nourishment received from the Mother. So by a Horse and She-Asse a *Mule* is generated, which is like neither, but participates of both, differing from the Horse, especially in the Ears and Tail ; since the Ass
abounding

abounding in that nourishment which produces the Ears, and wanting that which gives a long Tail, it must necessarily be like the Mother in those two particulars. So from a *White* Man and *Negro* Woman a *Mestico* is born: And from a large Pigeon or *Cropper* and a small wild Hen Pigeon, the Young are like neither; the Egg of the Female is not sufficient to nourish the *Animalcule* of the Male, so as to give it the Size of its Father. And thus Plants receive a great alteration from the different Soils in which the Seeds are planted. So *Apples* brought from *France* are with us in great esteem; and what care soever we take in the Trees themselves, yet they soon degenerate in our Soil; which change proceeds from the different Salts they meet with in the ground. And I believe if we could take the *Embrio* Plant out of one Seed and put it into another, so as it would grow, we should have a new Plant from thence like to neither: As if we should take the *Embrio* out of the Walnut (which I will liken to the *Animalcule* of the *Horse*) and so join it to the Seed of the *Chestnut* (which I compare to the *Matrix* of the *Ass*) that it would grow, the Plant produced by this Union would be a new and unknown Tree.

Willows are usually planted by thrusting a Stake into the Ground in wet places, yet finding several young ones on the Banks of Rivers, I judged these grew from the Seed. Wherefore in the beginning of *June*, examining the downy Seeds of these Plants, I found several brownish Particles, not much bigger than Sand; which the Microscope discover'd to be the Seeds thereof, which are contained in several little Violet-colour'd Boxes, of which in a little Sprig there were 75 placed by one another, each containing 3, 4, or 5 small Seeds, encompassed with a pappous Down. *Fig. 9.* represents these Seeds of the natural bigness. The Down or Pappous part is joined by one common Knot or Center first, and so to the Seed, and consists of 2, 3, 4, 5 or 6 small Threds, which so

Soon as the *Capfula* breaks upon the ripening of the Seed, spreads its self every way, as *Fig. 10.* tho' before the Threds were cloed up in one, as *Fig. 11.* by which means it easily carries the small Seeds on the Wings of the Wind to great distances. Viewing these Seeds more nicely, I saw that part whence the Root has its beginning (which makes one third part of the Seed) furnish'd with very many Vessels, consisting only of oblong and round Particles. The rest of the Seed consisted of two Lobes of a dark herby Colour made up of Globules, and between these, two very small Points rising up, which were the beginnings of the Leaves of the Tree or *Embrio* Plant, which the Lobes themselves were to nourish till it should be furnish'd with a Root to provide for it self.

I took some of these very small Seeds, and sowed them in wet Sand in my Closet in *June*, the better to discover the manner of their growth. These Seeds being very much dried, and thereby shrunk, appeared thro' the Microscope, as *Fig. 12.* though they were not all alike, some being more, some less dried up. *A B E F* is that part whence the Root shoots forth. When they had lain in the wet Sand 36 hours, they shewed as *Fig. 13.* the Proportion of the part *G H K L* being then considerable, and in so short a time 6 Roots were shot out from it, and the two Lobes *H I K* began to shew themselves. In 72 Hours the Roots began to divide and ramify, and to take hold on the Sand. That which is observable in this Tree is, that the Seeds come to their perfect maturity before the Leaves of the Tree have their full growth, whereas other Trees perfect not their Seeds till after the Fruit in *Autumn*; so that this Tree has its young Plant grown up the first Year. The same is observable in the *Elm*; some of the Seeds whereof I gather'd in *May*, dry'd and sow'd them, and in three days they sprung up. I try'd the same in the downy Seeds of
the

the *Poplar* and *Indian Cotton*. If these distinctions of parts are so soon visible in these small Seeds, why should we doubt the production of an *Animal* from the so often named *Animalcules*. Indeed we must own our selves at a stand, when we would find out how these *Animalcules* receive Life, and that not before the *Male* has attained a certain Age; and the rather, since we hold that the matter whence these *Animalcules* proceed, was likewise in that *Animalcule* it self when it was first committed to the *Matrix*. And indeed that very extraordinary minuteness, by which one Creature is transmitted to another, is incomprehensible.

Nor can we be better satisfied as to this matter in Trees than Men; for we see plainly, that very many Trees growing from Seed are some years before they bring forth Fruit and Seeds, at least such Seeds as will produce another Plant. So that we cannot say, that that Seed which will produce a Tree depends only on the Tree; but that the substance of the Seed, by means whereof a Tree is propagated, depends on that Seed from whence the Tree it self also proceeded. And tho' we may after some manner imagine how the Fruit, as an Apple or Pear, consisting of several round Particles (to omit the Vessels) may be produced, since there are 8 or 10, it may be more Ligaments (each whereof has a multitude of Vessels) which may transmit several Juices; yet how can we conceive that the Origine of a Plant can be thus formed. So that we see the beginning of the Propagation of the Tree is to us incomprehensible, although we see it done before our Eyes; and we may suppose it after the same way as it is in Man. To conclude, the Tree after 8 or 10 years begins to bear Seed, which depends not only on the Tree, but on the former Seed: So it is in the *Male Sperme*, which has its Original not only from the *Male*, but from the *Animalcule* from

whence the Male its self was produced. So that the first essential beginnings of things which are incomprehensibly small, will be always hidden from us.

IV. *Part of a Letter from Sir R. B. S.R.S. to Dr. Lister, concerning the Giants Causeway in the County of Antrim in Ireland.*

Old Bawn, Apr. 24. 1693.

————— Concerning the Giants Causey. Prolixity in a Philosophical Description I'm sure you'll pardon; for I was very exact in getting it from a person that was *rei compos*, perhaps *peritus*; a Scholar (a Master of Arts in *Cambridge*) and a Traveller, who went on purpose the last Summer with the present Bishop of *Derry* to see it. It is in the County of *Antrim*, about 7 Miles East of *Colrain*, and 31 Miles to the East of the mouth of the River of *Derry*. The Coast there is a very great height from the Sea, but rising gradually on the Land side to the edge of the Precipice, it is all cover'd with an excellent sweet Grass; when you come to the Precipice, there is no going down there it is so perpendicularly steep, but with much Labour and some Hazard it may be climb'd up. By other ways and windings one comes down to the *Strand*; in which, from the foot of this Precipice, there runs out Northward, into the Main Ocean, a raised Causeway of about 80 foot broad, and about 20 foot high above the rest of the *Strand*; its sides are perpendicular, it went on above two hundred foot to the Sea-Water; that is, it was so far in view; but as
he

